RF:sj 11/7/01 128.815USN

EXPRESS MAIL LABEL NO. EL675382049US
Date of Mailing: 7 November 2001

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING FILING UNDER 35 U.S.C. 371

Attorney Docket No.: 128.815USN

Int'l. Application No.:	PCT/SE99/00773
Int'l. Filing Date:	7 May 1999
Priority Date Claimed:	7 May 1999
Title of Invention:	FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE
Applicant(s) for DO/ES/US:	Lennart Westerberg, George W. Bearry, Patrik Lownertz, Don Parker

Applicant herewith submits to the United States Designated/Elected/Office (DO/EO/US) the following items and other information:

1. [X] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 37 U.S.C. 371.

3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2)
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office(RO/US).

7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.

9. [X] An (unsigned) oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

11. [ ] An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.

12. [ ] An assignment document for recording. A cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.

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13. [X] A FIRST preliminary amendment.

14. [ ] Applicant qualifies for Small Entity Status (37 C.F.R. 1.9(f) and 1.27(b)).

16. [ ] Other items or information: (if any)

17. [X] Basic National Filing Fee of **$1040.00** is submitted (Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee 37 C.F.R. 1.44.5(a)(2) paid to U.S.P.T.O.).

CLAIMS AS FILED			
For	Number Filed	Number Extra	Basic Fee $1040.00 Rate
Total Claims	14 - 20	= 0	x $18.00 = $0.00
Ind. Claims	1 - 3	= 0	x $84.00 = $0.00

19. [ ] Reduction by 1/2 for filing by small entity, if applicable. Applicant qualifies as small entity.
TOTAL FILING FEE: **$500.00.**

20. [ ] Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). **$40.00** per property.

21. [X] A check in the amount of **$1040.00** to cover the above fees is enclosed.

23. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 06-0243.

Respectfully submitted,

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Art Unit

Lennart Westerberg, George W. Bearry, Patrik Lownertz, and Don Parker

Serial No.

Filed: Herewith

For: FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE

Examiner:

Date: 7 November 2001

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Preliminary to examination, please amend the above-identified patent application as follows:

In the claims:

Cancel claims 1-19 and replace with the following claims.

--20. A feeding device system for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, comprising:

a feeding device having an upper part having an inlet defined therein for receiving a slurry of the burned lime and the

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soda liquor for enabling a formation of the slurry inside the feeding device;

an elongate and slender feed vessel in operative engagement with the feeding device, the feed vessel comprising a lower part having an outlet defined therein for the slurry;

a trash trap disposed in the feeding device, the trash trap comprising a discharge device, disposed at a bottom part of the trash trap, for coarse burned lime, the trash trap having agitating means, at the bottom part of the trash trap, for agitating the slurry; and

a pump operatively connected to the feeding device and a reaction vessel.

21. The feeding device system according to claim 20 wherein, the feed vessel has an internal liquor level of at least 1.5 meters.

22. The feeding device system according to claim 20 wherein, the feed vessel has an internal liquor level of at least 2 meters.

23. The feeding device system according to claim 20 wherein, the feed vessel has an internal liquor level of at least 3 meters.

24. The feeding device system according to claim 20 wherein the feed vessel has an inner diameter of between 0.1-1.5 meters.

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25. The feeding device system according to claim 20 wherein the feed vessel has an inner diameter of between 0.2-1 meters.

26. The feeding device system according to claim 20 wherein the feed vessel has an inner diameter of between 0.3-0.8 meter.

27. The feeding device system according to claim 20 wherein the feeding device comprises a cyclone in the upper part of the feeding device, the cyclone having inlets defined therein for receiving the burned lime and the soda liquor for formation of the slurry inside the cyclone.

28. The feeding device system according to claim 20 wherein the feeding device comprises a cyclone in the upper part of the feeding device, the cyclone having inlets defined therein for receiving the burned lime and the soda liquor for formation of the slurry just below the cyclone.

29. The feeding device system according to claim 20 wherein the trash trap constitutes a liquid filled branch-off to the feed vessel.

30. The feeding device system according to claim 20 wherein the pump is designed to pump the slurry when the slurry contains a substantial amount of coarse burned lime.

31. The feeding device system according to claim 20 wherein the pump is designed to crush oversized burned lime between a rotor part of the pump and a stationary part of the pump.

32. The feeding device system according to claim 20 wherein the pump has a first net pressure suction height requirement and is arranged to provide a lower pressure increase in the slurry and the feeding device system has a secondary pump that has a second net pressure suction height requirement and is arranged to provide a remaining higher pressure increase in the slurry for feeding the into the reaction vessel, the second net pressure suction height requirement being greater than the first net pressure suction height requirement.

33. The feeding device system according to claim 20 wherein the agitating means has an inlet defined therein for receiving a soda liquor.--

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PATENT

REMARKS

Reconsideration of the application is respectfully requested. The original claims 1-19 have been canceled and the new claims 20-33 have been added to the application so that the application better conforms to U.S. Patent Practice. A copy of the original claims is attached as Appendix A.

An abstract on a separate page has been added.

The application is submitted to be in condition for allowance, and such action is respectfully requested.

Respectfully submitted,

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PATENT

APPENDIX A
Original Claims

1. Feeding device (1) for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, liquor to caustic soda, which feeding device (1), in its upper part, comprises an inlet for a slurry of said burned lime and said soda liquor, or inlets (3, 4) for said burned lime and said soda liquor, respectively, for enabling formation of said slurry inside said feeding device, and which feeding device comprises a feed vessel (9) of tall and slender shape, which feed vessel in its lower part comprises an outlet (10) for said slurry, which outlet, via one or more pump(s) (24, 25), is operatively connected to said reaction vessel, c h a r a c t e r i s e d in that said feeding device (1) further comprises a trash trap (6), which trash trap (6) comprises a discharge device (11, 12, 13) for coarse burned lime or other non desired solid material, and which trash trap also comprises an outlet (7), at the bottom part thereof, for soda liquor and/or comprises an agitator device.

2. Feeding device according to claim 1, c h a r a c t e r i s e d in that said feed vessel (9) has an internal liquor level of at least 1.5 metres, preferably at least 2 metres and most preferably at least 3 metres.

3. Feeding device according to claim 1 or 2, c h a r a c t e r i s e d in that said feed vessel (9) has an inner diameter of 0.1-1.5 metres, preferably 0.2-1 metres and most preferably 0.3-0.8 metres.

4. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d in that the feeding device (1), in said upper part thereof, comprises a cyclone (2) including said inlets (3, 4) for the burned lime and the soda liquor, respectively, for enabling formation of said slurry inside or just below the cyclone.

5. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d in that said trash trap (6) constitutes a liquid filled branch-off to said feed vessel (9).

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6. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d in that said one or more pump(s) (24, 25) is/are designed to pump said slurry even if it contains a substantial amount of coarse burned lime.

7. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d in that at least one of said one or more pump(s) (24, 25), preferably a first/primary one (24), is designed to crush oversized burned lime between a rotor part thereof and a stationary part thereof.

8. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d in that a primary pump (24) of said one or more pump(s) has a low net pressure suction height requirement and is arranged to provide a relatively low pressure increase in the slurry, whereas a secondary pump (25) of said one or more pump(s) has a higher net pressure suction height requirement and is arranged to provide the remaining pressure increase in the slurry for feeding it into said reaction vessel.

9. A process for reacting a soda liquor with burned lime for production of caustic soda, c h a r a c t e r i s e d by the steps of:
   (a) forming a slurry of said burned lime and a first part (23) of said soda liquor and allowing said slurry a retention time of 10-150 seconds in a feed vessel (9),
   (b) preheating (28) a second part (26) of said soda liquor,
   (c) combining (34) said slurry from step (a) and said preheated second part of said soda liquor of step (b),
   (d) maintaining (29) the combined slurry and liquor at an elevated pressure and at an elevated temperature for completion of the reaction between the burned lime and the soda liquor to yield caustic soda and lime mud.

10. A process according to claim 9, c h a r a c t e r i s e d in that said feed vessel (9) is filled with enough liquid/slurry to provide a hydrostatic pressure high enough prevent boiling due to an exothermic reaction between said burned lime and said soda liquor.

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11. A process according to claim 9 or 10, c h a r a c t e r i s e d in that step (d) is performed at a pressure of at least 1.1 bar(abs), preferably at least 1.5 bar and more preferred at least 2 bar and at a temperature of 100-160°C, preferably 110-150°C and more preferred 120-140°C.

12. A process according to any of claims 9-11, c h a r a c t e r i s e d in that the retention time in step (d) is 1-60 minutes, preferably 10-40 minutes.

13. A process according to any of claims 9-12, c h a r a c t e r i s e d in that the retention time in step (a) is 20-120 seconds, preferably 30-60 seconds.

14. A process according to any of claims 9-13, c h a r a c t e r i s e d in that said first part (23) of said soda liquor constitutes about 1/3 to 1/2 of the entire amount of soda liquor which participates in the reaction, whereas said second part (26) of said soda liquor constitutes about 1/2 to 2/3 of the entire amount of soda liquor which participates in the reaction.

15. A process according to any of claims 9-14, c h a r a c t e r i s e d in that said second part (26) of said soda liquor is preheated to about 5-10°C below the temperature of step (d), preferably by indirect heat exchanging (28) against caustic soda (27) which is produced in the process.

16. A process according to any of claims 9-15, c h a r a c t e r i s e d in that step (d) is succeeded by the step of
(e) allowing coarse, unreacted, burned lime to settle and thereafter discharging (30) it.

17. A process according to any of claims 9-16, c h a r a c t e r i s e d in that step (d) is succeeded by the step of
(f) filtering (32) said lime mud and caustic soda under elevated pressure and elevated temperature, preferably about the same temperature as in step (d), in order to separate said caustic soda from said lime mud (33).

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18. Feeding system for feeding burned lime to a reaction vessel (29) for causticizing a soda liquor to caustic soda, c h a r a c t e r i s e d in that said feeding system comprises:
(aa) a feeding device (1), which feeding device includes an inlet for a slurry of said burned lime and a first part (23) of said soda liquor, or inlets for said burned lime and said first part of said soda liquor, respectively, for enabling formation of said slurry inside said feeding device,
(bb) one or more pump(s) (24, 25), which are arranged to pump the slurry from the feeding device (1) in (aa) to said reaction vessel (29),
(cc) a heater (28), which is arranged to heat a second part (26) of said soda liquor,
(dd) a distributing device (35), which is arranged to distribute said first part (23) of said soda liquor to the feeding device (1) in (aa) and to distribute said second part (26) of said soda liquor to the heater (28) in (cc), and
(ee) a combining device (34), which is arranged to combine said slurry, before or in connection with its inlet into said reaction vessel (29), with said heated second part (26) of said soda liquor.

19. Feeding system according to claim 18, c h a r a c t e r i s e d in that said feeding device utilises a feeding device according to any of claims 1-8.

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PATENT

APPENDIX B
Abstract

Feeding device for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda. The feeding device, in its upper part, comprises an inlet for a slurry of the burned lime and the soda liquor for formation of said slurry inside said feeding device. The system further comprises a tall and slender feed vessel having a lower part having an outlet defined therein for the slurry. The outlet, via a pump, is operatively connected to the reaction vessel. The process and the feeding system utilize the feeding device, in which process the slurry is created of the burned lime and a first part of the soda liquor, a second part being preheated before addition to the slurry, whereafter slaking and causticizing reactions are completed under elevated temperature and pressure.

RF:sj 26/02 128.615USN

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Art Unit

Lennart Westerberg, George W. Bearry, Patrik Lownertz, and Don Parker

Serial No. 10/031,277

Filed: November 7, 2001

For: FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE

Examiner:

Date: 26 February 2002

SUPPLEMENTAL PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231

Preliminary to examination, please amend the above-identified patent application as follows:

In the Specification:

Please add the following paragraph directly under the title:

--Prior Application

This application is a U.S. national phase application based upon International Application No. PCT/SE99/00773, filed 7 May 1999, and claims priority therefrom.

RF:cj 2/26/02 128.815USN

PATENT

REMARKS

Reconsideration of the application is respectfully requested. The application has been amended to include all earlier-filed applications for which priority has been claimed in accordance with 37 CFR 1.78. A copy of International Application No. PCT/SE99/00773 is being submitted herewith.

The application is submitted to be in condition for allowance, and such action is respectfully requested.

Respectfully submitted,

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FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE

TECHNICAL FIELD

The present invention relates to a feeding device for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda. The invention also relates to a process for reacting a soda liquor with burned lime for production of caustic soda, which process utilises said feeding device. Furthermore, the invention relates to a feeding system which utilises said feeding system.

STATE OF THE ART AND PROBLEMS

In the kraft pulping industry in which cellulose containing raw material is treated at high temperatures with cooking chemicals to yield cellulose pulp, it is of vital economic and environmental importance to recover and regenerate the spent cooking liquor with its dissolved wood substance as well as the cooking chemicals. This is achieved by extracting spent (black) cooking liquor from the digesters and further by washing the pulp discharged from the digesters with water, evaporating the liquor obtained and then combusting the evaporated liquor in a recovery boiler. From the bottom of the recovery boiler a smelt is taken out and dissolved in water to form a soda liquor (green liquor) which is a solution of mostly sodium carbonate and sodium sulphide. Alternatively, the soda liquor may be produced by substoichiometric gasification of the spent cooking liquor. The sodium carbonate content of the soda liquor is converted to sodium hydroxide by the addition of burned lime (CaO) in the so called causticizing process. In the causticizing process the burned lime forms insoluble lime mud ($CaCO_3$) which is separated from the caustic liquor - called white liquor -in a subsequent filtration step. The white liquor is thereafter reused as cooking liquor in the kraft cooking of the cellulose containing raw material.

The chemical reaction in the causticizing process proceeds in two reaction steps. In the first reaction step, usually carried out in an atmospheric so called lime slaker, the burned lime consisting mostly of calcium oxide is slaked by the water content of the green liquor to form hydrated lime.

$$CaO\ (s) + H_2O \rightarrow Ca(OH)_2\ (s) \qquad (1)$$

This first reaction is called the slaking reaction and it is rapid and strongly exothermic.

In the second reaction step the dissolved carbonate in the green liquor combines, conventionally in several atmospheric agitated reactor tanks in series, with the calcium in the slaked lime to form lime mud. At the same time the hydroxide content of the slaked lime goes into solution.

$$Ca(OH)_2\ (s) + CO_3^{2-} \leftrightarrow CaCO_3\ (s) + 2OH^- \qquad (2)$$

This second reaction is slower than the first reaction and is also an equilibrium reaction which means that all the dissolved carbonate will not react even if a surplus of burned lime is added.

It is further known in the art, from for example SE 504 212, to perform the causticizing at elevated pressure and temperature. The elevated temperature makes the causticizing reaction (2) proceed faster and the pressurised design prevents boiling and thus loss of the heat of reaction of the exothermic slaking reaction. Thus the heat of reaction can be preserved at the same time as it is utilised to increase the reaction rate of the second, slower reaction.

From US 4,627,888 it is known to perform a pressurised slaking process where the soda liquor to be causticized is divided into two parts, the first part being used for the slaking and the second part being added after the slaking for the actual causticizing process.

It has also been shown that if the product white liquor/lime mud slurry is kept under elevated pressure and temperature during a succeeding separation step, a further benefit can be elicited. As the viscosity of the white liquor is lower at higher temperature the capacity of a given filter can be higher at this temperature resulting in reduced filter size for a given capacity.

In conventional recausticizing systems, whether atmospheric or pressurised, the storage silo for burned lime is placed directly above or adjacent to the lime slaker and the burned lime is being fed to the slaker by one or several solids materials conveyors. This solution has a some disadvantages. If placed directly above the slaker, the structure for the storage silo becomes expensive as will the conveying system of burned lime from the lime kiln (where lime mud is reburned to CaO) to the silo. If placed more remotely from the slaker and in close vicinity to the lime kiln discharge, the conveyors to the slaker will instead become expensive. These disadvantages could be overcome if the lime slaker reactor could be fed by pumping burned lime from the storage silo as a slurry in green or white liquor. However such pumping of slurry does in itself have its difficulties:

- The lime slaking reaction is rapid and strongly exothermal so if slurried in hot liquor the liquor may be brought close to or to boiling reducing the available net pressure suction height (NPSH) for the slurry pump. This may cause the slurry pump to cavitate.
- The burned lime often contains oversize material, refractory or metal trash that may block or damage the feed pump or piping.

Other problems that are identified in conventional recausticizing systems are e.g. that feed-back control is complicated by the slow reaction (2) which is performed in a series of vessels and that the process equipment requires a large space.

BRIEF DESCRIPTION OF THE INVENTION

The present invention provides a feeding device in a slurry pumping system that overcomes the above difficulties, and also provides a process which utilises said feeding device.

Hence, there is provided a feeding device for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, wherein said feeding device, in its upper part, comprises an inlet for a slurry of said burned lime and said soda liquor, or inlets for said burned lime and said soda liquor, respectively, for enabling formation of said

slurry inside said feeding device, and wherein said feeding device comprises a feed vessel of tall and slender shape, which feed vessel in its lower part comprises an outlet for said slurry, which outlet, via one or more pump(s), is operatively connected to said reaction vessel.

The feed vessel preferably presents an internal liquor level of at least 1.5 metres, preferably at least 2 metres and most preferably at least 3 metres, whereas its inner diameter depends on the size of the slurry flow through the feed vessel and on the retention time, which is 10-150 seconds, preferably 20-120 seconds and even more preferred 30-60 seconds, giving an inner diameter of about 0.1-1.5 metres, preferably 0.2-1 metres and most preferably 0.3-0.8 metres. By the tall and slender shape of the feed vessel, a shape that is commonly referred to as a stand pipe, there is created a possibility to form a pumpable slurry of the burned lime and soda liquor, which slurry thus is formed in a volume which is small enough to prevent the exothermic reaction (1) from proceeding far enough to cause boiling, at the same time as a hydrostatic pressure, due to the height of the liquor level in the feed vessel, prevents the downstream one or more pump(s) from cavitating.

According to one aspect of the invention, the feeding device, in said upper part thereof, comprises a cyclone including said inlets for the burned lime and the soda liquor, respectively, for enabling formation of said slurry inside the cyclone or just below the cyclone.

According to another aspect of the invention, the feeding device further comprises a trash trap, which trash trap preferably constitutes a liquid filled branch-off to said feed vessel, which trash trap comprises means for discharging coarse burned lime or other non desired solid material, and which trash trap also comprises an inlet, at the bottom part thereof, for soda liquor and/or comprises an agitator device, such as for example a propeller or other agitator paddle.

According to yet another aspect of the invention, the one or more pump(s) is/are especially designed to handle a slurry with a substantial amount of coarse burned lime and at

least one of the pumps (preferably the first one) is designed to crush oversized burned lime between a rotor part and a stationary part in the pump.

The invention further presents a process for reacting a soda liquor with burned lime, by combined slaking and causticizing, for production of caustic soda,
comprising the steps of
(a) forming a slurry of said burned lime and a first part of said soda liquor and allowing said slurry a retention time of 10-150 seconds in a feed vessel,
(b) preheating a second part of said soda liquor,
(c) combining said slurry from step (a) and said preheated second part of said soda liquor of step (b),
(d) maintaining the combined slurry and liquor at an elevated pressure and at an elevated temperature for completion of the reaction between the burned lime and the soda liquor to yield caustic soda and lime mud.

According to one aspect of the process of the invention, said first part of said soda liquor constitutes about 1/3 to 1/2 of the entire amount of soda liquor which participates in the reaction, whereas said second part of said soda liquor constitutes about 1/2 to 2/3 of the entire amount of soda liquor which participates in the reaction. By dividing the soda liquor into these two streams, there can be created a slurry of the burned lime and the first part of the soda liquor, which slurry, due to the short retention time of step (a), will not have time to completely undergo the exothermic reaction (1) above before it is pumped into the pressurised reaction vessel, where the reactions (1), (2) are completed. By preheating a second part of the soda liquor, preferably by indirect heat exchange against a product caustic soda (white liquor), the reaction rate is further speeded up so that the reactions can be completed in a very short period of time and in process equipment which is much smaller and less space requiring than in conventional systems.

According to another aspect of the invention, said feed vessel is filled with enough liquid/slurry to provide a hydrostatic pressure high enough prevent boiling due to an exothermic reaction between said burned lime and said soda liquor.

According to yet another aspect of the invention, the process proceeds with the steps of,
(e) allowing coarse, unreacted, burned lime to settle and thereafter discharging it,
(f) filtering said lime mud and caustic soda under elevated pressure and elevated temperature, preferably about the same temperature as in step (d), in order to separate said caustic soda from said lime mud.

The invention further presents a feeding system for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, which feeding system comprises:
(aa) a feeding device, which feeding device includes an inlet for a slurry of said burned lime and a first part of said soda liquor, or inlets for said burned lime and said first part of said soda liquor, respectively, for enabling formation of said slurry inside said feeding device,
(bb) one or more pump(s), which are arranged to pump the slurry from the feeding device in (aa) to said reaction vessel,
(cc) a heater, which is arranged to heat a second part of said soda liquor,
(dd) a distributing device, which is arranged to distribute said first part of said soda liquor to the feeding device in (aa) and to distribute said second part of said soda liquor to the heater in (cc), and
(ee) a combining device, which is arranged to combine said slurry, before or in connection with its inlet into said reaction vessel, with said heated second part of said soda liquor.

The advantages of the feeding device and the process described above are several:

The pump-in feed system allows the burned lime storage silo to be placed lower than in a conventional system where the lime is added by gravity to the first of several reactor tanks.

The pump-in feed system utilising the feeding device allows the burned lime storage silo to be placed away from the reactor tank also facilitating retrofits of this system in existing plants.

The very high reaction rate of this process compared to the conventional makes the required reactor volume much smaller and thus gives lower space requirement and also lower equipment cost.

The high reaction rate makes feed-back control of the lime dosage more accurate as the time lag from dosing to completed reaction is greatly reduced.

The small reactor dimensions and fully pressurised reactor design greatly reduces the heat losses and thus makes control of the lime dosing based on measurement of the temperature rise caused by the exothermic slaking reaction (1) an accurate and simple control mechanism.

The high temperature during the white liquor/lime mud separation makes the filter area required smaller and thus reduces the size and cost of this filter.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is hereinafter described in more detail with reference to the drawings, of which:

Fig. 1 is showing one embodiment of a feeding device according to the invention.

Fig. 2 is showing a schematic flow chart of one embodiment of a process according to the invention.

DETAILED DESCRIPTION OF THE FIGURES

Detail no. 1 in Fig. 1 denotes an embodiment of a feeding device according to the invention. The feeding device generally comprises a cyclone 2 in its upper part, including inlets 3, 4 for burned lime and soda liquor, respectively. Preferably, the inlet 4 for soda liquor is arranged tangentially, so that there is formed a curtain of liquor around the burned lime which is falling down, which liquor curtain assists in preventing dusting. The soda liquor normally constitutes of green liquor, which preferably has been clarified, but also white liquor may be used. The outlet 5 of the cyclone 2 is attached to a trash trap 6. The trash trap 6 extends as a vertical pipe which is aligned with the outlet 5

of the cyclone 2 and which in its lower part comprises a preferably tangential inlet 7 for soda liquor. The trash trap further comprises feed-out means for coarse burned lime or other contaminating solids, which feed-out means in the shown embodiment includes two intermittently operating sliding damper valves 11, 12. It is to be understood that a variety of other feed-out means are conceivable, including a large number of valve types. In the shown embodiment, there is used two valves 11, 12 in order to create a lock system, where the valve 11 is opened first so that trash may fall down by gravity into a lock chamber 13. The valve 11 is then closed and the valve 12 is instead opened in order to empty the lock chamber 13.

The trash trap 6 is branched in its upper part and the branch-off pipe constitutes the feed vessel 9 according to the invention. The feed vessel is of tall and slender shape, according to the above mentioned, and is generally referred to as a stand pipe, although it need not be exactly vertical as conventional standpipes usually are. Instead, the longitudinal axis of the feed vessel/standpipe 9 according to the invention may differ from the vertical plane with as much as 45°, preferably at most 35°. The feed vessel provides a small volume, and thereby a short retention time at the same time as it provides a hydrostatic pressure height (net pressure suction height) which is high enough to prevent boiling due to the exothermic slaking reaction and to prevent cavitation in the downstream pump. At the lower end of the feed vessel 9 there is provided an outlet 10.

Operatively connected to the outlet 10 of the feed vessel 9, there are one or more pumps, preferably two pumps, the first 24 of these pumps preferably being directly connected to the outlet 10. The first 24 of these pumps is also preferably designed to crush oversized burned lime between a rotor part thereof and a stationary part thereof. Both or all of the pumps are besides this also designed to be able to pump the slurry of lime and soda liquor even if it contains substantial amounts of coarse burned lime. Further, the first (primary) pump is preferably selected to have a low net pressure suction height requirement and a low pressure rise, whereas the second pump is a so called booster pump with a higher net pressure suction height requirement, which is easily met through the pressure rise of the first pump, and also with a higher pressure rise. The second, and any optional further pump is preferably selected to be a conventional, commercial rub-

ber lined pump for mineral suspensions.

In the cyclone 2, or just below the cyclone 2, there is formed a slurry of the entering burned lime and clarified green liquor. The slurry discharges by gravity into the trash trap 6. At the bottom of the trash trap a second portion of the green liquor is tangentially added 7 in order to mix the slurry and to flush small particles from the trap into the feed vessel 9. Alternatively, the trash trap may be provided with an agitator device in its lower part. The overflow from the trash trap 6 flows into the feed vessel 9. The trash trap is periodically emptied from coarse solids by opening a large diameter discharge valve at its bottom. The slurry in the feed vessel proceeds through the outlet 10 into the downstream pump (Fig. 2).

Turning now to Fig. 2, showing a flow chart of an embodiment of the process according to the invention, detail no. 20 denotes a storage tank for burned (sometimes referred to as reburned) lime, which is being fed in from a lime kiln (not shown). From the storage tank 20 the burned lime is conveyed by a solids material conveyor 21 to the top of the feeding device 1. In the feeding device 1 there is formed a slurry of a first part 23 of the green liquor 22 and the burned lime. The flow in conduit 22 is typically about 1000-8000 m^3 green liquor per 24 hours and the lime dosage from storage tank 20 is about 55-75 kg/m^3 green liquor. Preferably about 1/3 to 1/2 of the green liquor provided in 22 is added 23 to the feeding device 1. The temperature of the green liquor which is supplied 23 to the feeding device is typically 90-97°C, although lower temperatures are conceivable. The slurry of burned lime and green liquor proceeds through the short retention time feeding device 1, the slaking reaction commencing, and pumps 24 and 25 according to the above description. A second part 26 of the green liquor in 22 is heated, preferably by indirect heat exchanging in heat exchanger 28 against a product white liquor 27, before being brought together, in a combining device 34, with the slurry downstream of the pumps 24 and 25. The slurry and the second, preheated part of the green liquor may be combined either prior to the entry in a pressurised, high temperature causticizing reactor 29, or by separate inlets, inside the reactor. The temperature increase compared to the conventional atmospheric process, achieved by the preheating of the green liquor in combination with the heat of reaction of the slaking reaction will

make the causticizing reaction proceed at an increased rate to complete the reactions in a time which is much shorter than the conventional reaction time.

The green liquor 22 is divided into said first 23 and second 26 parts by a distributing device 35, which may be a conventional tee-conduit or other similar device, including a valve (not shown), which controls the flow rate in the conduit for the first part 23 and the conduit for the second part 26. Also, the combining device 34 may be a tee-conduit, a mixer, or other similar device. It is however also conceivable that the combination of the slurry and the pre-heated green liquor is performed directly in or in connection with a pump, such as one of the pumps 24 or 25. Whereby the pre-heated green liquor from heater 28 may be introduced into said pump via an inlet therein. Also, as described above, the combination may be performed directly in or in connection with the reactor 29.

The pressurised causticizing reactor 29 may be of known design, having intermediate partitions and scraping devices/agitators. The pressure in the reactor is suitably at least 1.1 bar(abs), preferably at least 1.5 bar and more preferred at least 2 bar and the temperature is 100-160°C, preferably 110-150°C and more preferred 120-140°C.

When the causticizing reaction is completed, the resulting white liquor/lime mud slurry is led through a gravity settling zone in the bottom part of the reactor where any remaining course material, so called grits, is separated from the mud slurry and discharged through a discharge device into conduit 30, or directly into a (not shown) vessel for washing and dewatering. The main portion of the slurry is led from the upper part of the settling zone, via a conduit 31, to a pressurised filter 32, preferably a pressure disc filter, which preferably operates at essentially the same temperature as the prevailing temperature in reactor 29. In the filter 32, the lime mud 33 is separated from the product white liquor 27, whereafter the white liquor is used to preheat the second part 26 of the incoming green liquor 22, and further used in the cooking process for the cellulose containing raw material. The green liquor in 26 is suitably heated to a temperature about 5-10°C below the temperature in reactor 29. The lime mud in 33 is slurried in hot water (not shown) and led away from the filter 32.

According to one aspect of the invention, both the feeding device 1 and the reactor 29 are placed with their support structure on the ground plane, the outlet for the grits 30 being located about 1.5-2 metres above the ground and the storage tank 20 for burned lime having its outlet located about 6-7 meters above the ground.

The invention is not limited to the above shown embodiment, but may be varied within the scope of the claims. Thus, the skilled man will easily see several modifications which can be made without departing from the scope of the claims. Thus, he will for example realise that the slurry in the feeding device can be accomplished by other means than the shown cyclone and also that the second part of the green liquor, which is preheated, can be preheated by other means than the shown heat exchange against product white liquor. Further, the skilled man will realise that the feed-in system, including the feeding device, can be used also for not pressurised applications as an alternative to conventional expensive conveyors for dry materials.

AMENDED CLAIMS

[received by the International Bureau on 30 August 2000 (30.08.00);
original claims 1 and 5 amended ; remaining claims unchanged ;
(4pages)]

1. Feeding device (1) for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, which feeding device (1), in its upper part, comprises an inlet for a slurry of said burned lime and said soda liquor, or inlets (3, 4) for said burned lime and said soda liquor, respectively, for enabling formation of said slurry inside said feeding device, and which feeding device comprises a feed vessel (9) of tall and slender shape, which feed vessel in its lower part comprises an outlet (10) for said slurry, which outlet, via one or more pump(s) (24, 25), is operatively connected to said reaction vessel, c h a r a c t e r i s e d i n that said feeding device (1) further comprises a trash trap (6), which trash trap (6) comprises a discharge device (11, 12, 13) for coarse burned lime or other non desired solid material, and which trash trap also comprises an inlet (7), at the bottom part thereof, for soda liquor and/or comprises an agitator device.

2. Feeding device according to claim 1, c h a r a c t e r i s e d i n that said feed vessel (9) has an internal liquor level of at least 1.5 metres, preferably at least 2 metres and most preferably at least 3 metres.

3. Feeding device according to claim 1 or 2, c h a r a c t e r i s e d i n that said feed vessel (9) has an inner diameter of 0.1-1.5 metres, preferably 0.2-1 metres and most preferably 0.3-0.8 metres.

4. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d i n that the feeding device (1), in said upper part thereof, comprises a cyclone (2) including said inlets (3, 4) for the burned lime and the soda liquor, respectively, for enabling formation of said slurry inside or just below the cyclone.

5. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d i n that said trash trap (6) constitutes a liquid filled branch-off to said feed vessel (9).

6. Feeding device according to any of the preceding claims, c h a r a c t e r i s e d i n that said one or more pump(s) (24, 25) is/are designed to pump said slurry even if

it contains a substantial amount of coarse burned lime.

7. Feeding device according to any of the preceding claims, characterised in that at least one of said one or more pump(s) (24, 25), preferably a first/primary one (24), is designed to crush oversized burned lime between a rotor part thereof and a stationary part thereof.

8. Feeding device according to any of the preceding claims, characterised in that a primary pump (24) of said one or more pump(s) has a low net pressure suction height requirement and is arranged to provide a relatively low pressure increase in the slurry, whereas a secondary pump (25) of said one or more pump(s) has a higher net pressure suction height requirement and is arranged to provide the remaining pressure increase in the slurry for feeding it into said reaction vessel.

9. A process for reacting a soda liquor with burned lime for production of caustic soda, characterised by the steps of:
(a) forming a slurry of said burned lime and a first part (23) of said soda liquor and allowing said slurry a retention time of 10-150 seconds in a feed vessel (9),
(b) preheating (28) a second part (26) of said soda liquor,
(c) combining (34) said slurry from step (a) and said preheated second part of said soda liquor of step (b),
(d) maintaining (29) the combined slurry and liquor at an elevated pressure and at an elevated temperature for completion of the reaction between the burned lime and the soda liquor to yield caustic soda and lime mud.

10. A process according to claim 9, characterised in that said feed vessel (9) is filled with enough liquid/slurry to provide a hydrostatic pressure high enough prevent boiling due to an exothermic reaction between said burned lime and said soda liquor.

11. A process according to claim 9 or 10, characterised in that step (d) is performed at a pressure of at least 1.1 bar(abs), preferably at least 1.5 bar and more preferred at least 2 bar and at a temperature of 100-160°C, preferably 110-

150°C and more preferred 120-140°C.

12. A process according to any of claims 9-11, characterised in that the retention time in step (d) is 1-60 minutes, preferably 10-40 minutes.

13. A process according to any of claims 9-12, characterised in that the retention time in step (a) is 20-120 seconds, preferably 30-60 seconds.

14. A process according to any of claims 9-13, characterised in that said first part (23) of said soda liquor constitutes about 1/3 to 1/2 of the entire amount of soda liquor which participates in the reaction, whereas said second part (26) of said soda liquor constitutes about 1/2 to 2/3 of the entire amount of soda liquor which participates in the reaction.

15. A process according to any of claims 9-14, characterised in that said second part (26) of said soda liquor is preheated to about 5-10°C below the temperature of step (d), preferably by indirect heat exchanging (28) against caustic soda (27) which is produced in the process.

16. A process according to any of claims 9-15, characterised in that step (d) is succeeded by the step of
(e) allowing coarse, unreacted, burned lime to settle and thereafter discharging (30) it.

17. A process according to any of claims 9-16, characterised in that step (d) is succeeded by the step of
(f) filtering (32) said lime mud and caustic soda under elevated pressure and elevated temperature, preferably about the same temperature as in step (d), in order to separate said caustic soda from said lime mud (33).

18. Feeding system for feeding burned lime to a reaction vessel (29) for causticizing a soda liquor to caustic soda, characterised in that said feeding system comprises:

(aa) a feeding device (1), which feeding device includes an inlet for a slurry of said burned lime and a first part (23) of said soda liquor, or inlets for said burned lime and said first part of said soda liquor, respectively, for enabling formation of said slurry inside said feeding device,

(bb) one or more pump(s) (24, 25), which are arranged to pump the slurry from the feeding device (1) in (aa) to said reaction vessel (29),

(cc) a heater (28), which is arranged to heat a second part (26) of said soda liquor,

(dd) a distributing device (35), which is arranged to distribute said first part (23) of said soda liquor to the feeding device (1) in (aa) and to distribute said second part (26) of said soda liquor to the heater (28) in (cc), and

(ee) a combining device (34), which is arranged to combine said slurry, before or in connection with its inlet into said reaction vessel (29), with said heated second part (26) of said soda liquor.

19. Feeding system according to claim 18, c h a r a c t e r i s e d i n that said feeding device utilises a feeding device according to any of claims 1-8.

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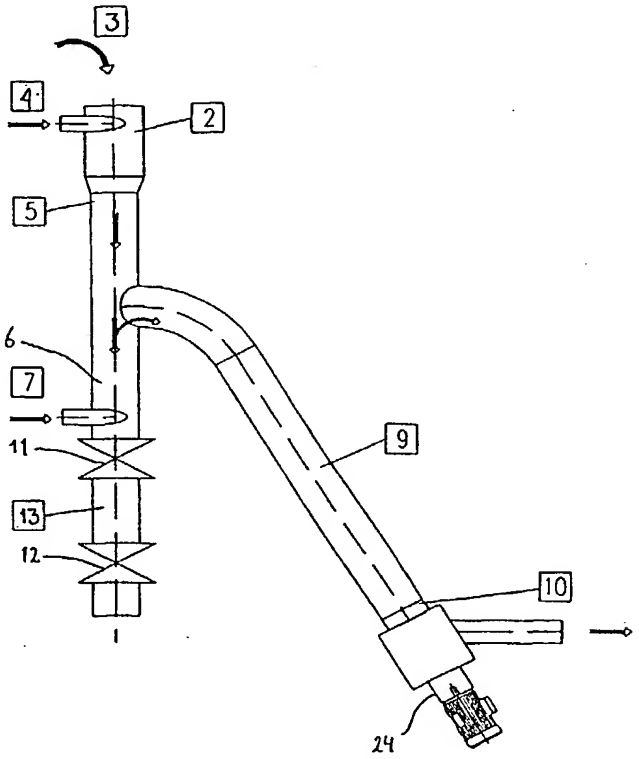
(54) Title: FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE

(57) Abstract

Feeding device (1) for feeding burned lime to a reaction vessel for causticizing a soda liquor to caustic soda, which feeding device, in its upper part, comprises an inlet for a slurry of said burned lime and said soda liquor, or inlets (3, 4) for said burned lime and said soda liquor, respectively, for formation of said slurry inside said feeding device, and further comprises a feed vessel (9) of tall and slender shape, which feed vessel in its lower part comprises an outlet (10) for said slurry, which outlet, via one or more pump(s) (24, 25), is operatively connected to said reaction vessel. The invention also relates to a process and a feeding system which utilises said feeding device, in which process the slurry is created of said burned lime and a first part of said soda liquor, a second part being preheated (28) before addition to the slurry, whereafter slaking and causticizing reactions are completed under elevated temperature and pressure.



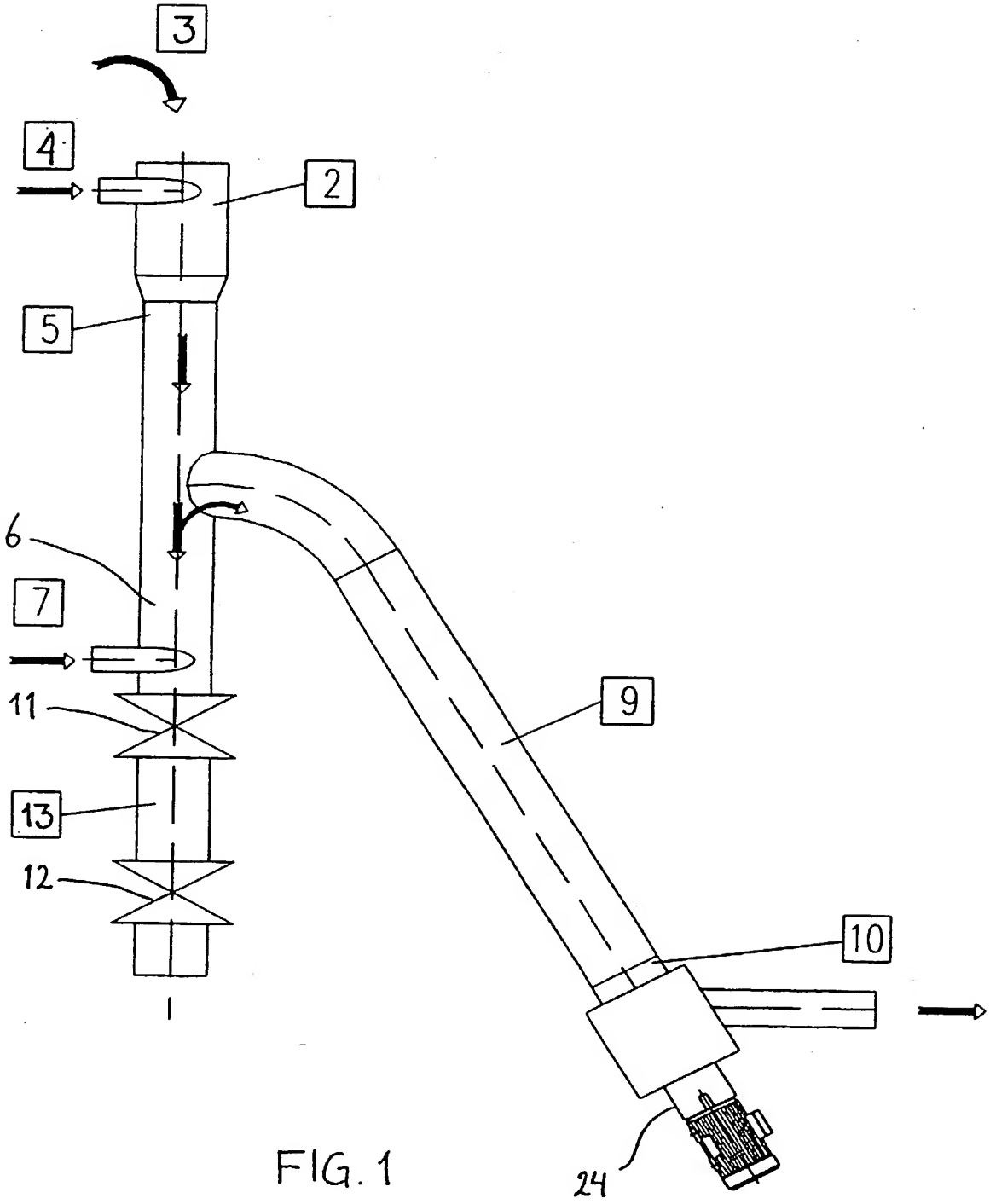


FIG. 1

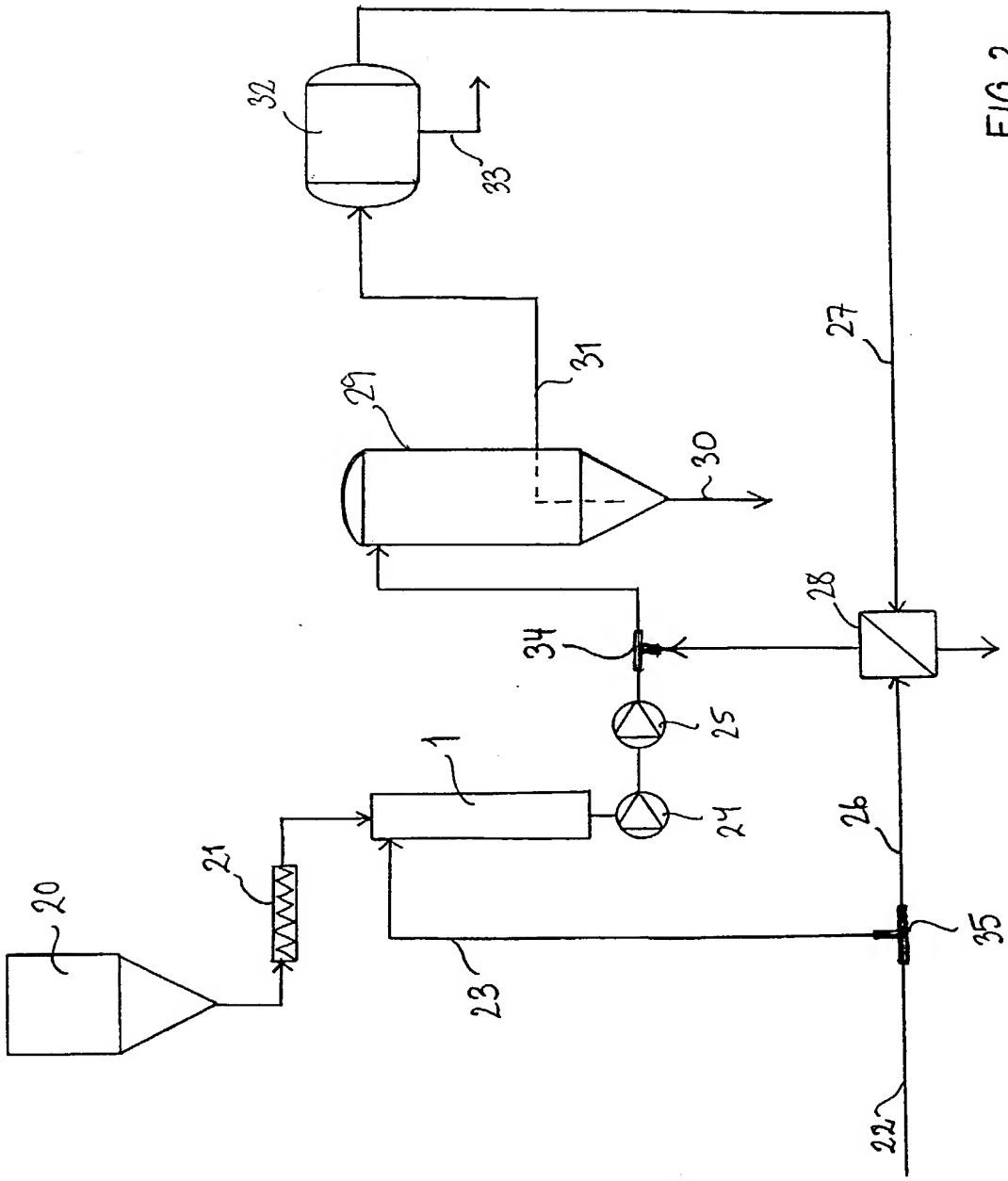


FIG. 2

RF:aj 10/25/01 128.815USN

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled FEEDING DEVICE AND PROCESS AND FEEDING SYSTEM WHICH UTILISE THE FEEDING DEVICE, the specification of which was filed as International Patent Application No. PCT/SE99/00773, on 7 May 1999.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a). If this is a continuation-in-part application filed under the conditions specified in 35 U.S.C. § 120 which discloses and claims subject matter in addition to that disclosed in the prior copending application, I further acknowledge the duty to disclose material information as defined in 37 CFR §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
PCT/SE99/00773 (Number)	PCT (Country)	7 May 1999 (Day/Month/Year)	[X] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior

§ 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(not applicable)	(n/a)	(not applicable)
(Application Serial No.)	(Filing Date)	(Status: patented, pending, abandoned)

The undersigned hereby authorizes Rolf Fasth, the U.S. attorney named herein, to accept and follow instructions from Kvaerner Pulping AB as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between Rolf Fasth and the undersigned. In the event of a change in the persons from whom instructions may be taken, Rolf Fasth will be so notified by the undersigned.

I hereby appoint Rolf Fasth, Registration No. 36,999, to prosecute this application, to file a corresponding international application, and to transact all business in the Patent and Trademark Office connected therewith.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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